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Calculating the Cost-Push Effects of Increasing the Domestic Price of Crude Oil Towards the International Price Using the Statistics Canada Price Model

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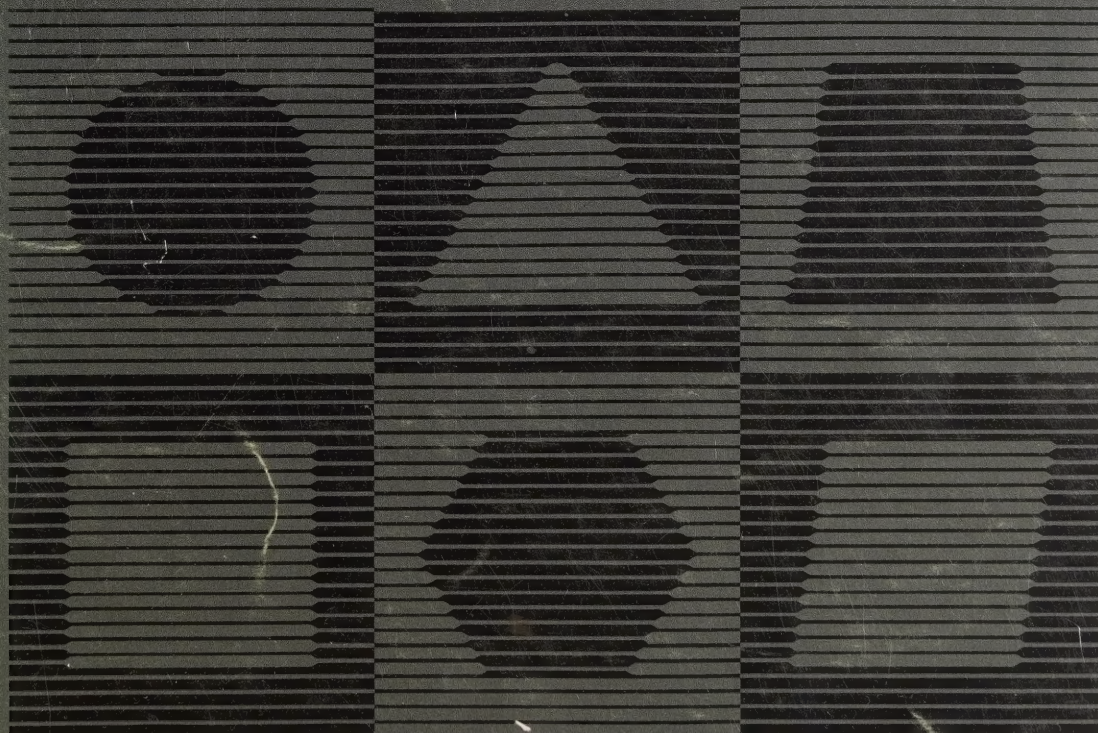# Structural Analysis Division

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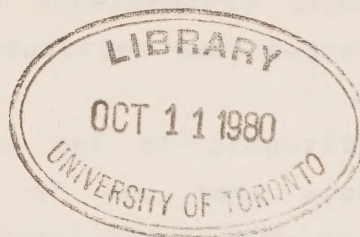
Calculating the Cost-Push Effects of Increasing the Domestic Price of Crude Oil Towards the International Price Using the Statistics Canada Price Model

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NOTE

The Statistics Canada price models belong to the family of cost-push models traditionally associated with input-output models. These models are in effect the dual of the output determination models. Instead of analysing the propagation of demand throughout the economic system the price model serves to analyse the propagation of factor prices throughout the system.

The characteristic common to all price models of this family is the assumption of cost-push behaviour. It is assumed that, when an industry is faced with a change in the costs of its raw material or primary inputs, it will adjust its product price in such a way as to offset the increase in costs. To the extent that an industry's product is an intermediate input into other industries, the other industries must adjust their product prices as well.

The model is based on a set of proportionality assumptions. It makes use of the same accounting identities and the same structural relationships as the input-output model.

These relationships have the following implications concerning price formation behaviour:

1. The price of each domestically produced commodity is a weighted combination of the output prices of the industries which produce the commodity.
2. The price of an industry's output is determined by the cost of its inputs, i.e., intermediate inputs of goods and services domestically produced and imported, indirect taxes, wages and salaries, and profits. This means that an industry, faced with a change in the costs of its inputs, will adjust its output prices in such a way as to cover its costs and maintain its profit margins. In other words,

increases in costs are passed on to the purchasers of goods. This assumption gives the model 'cost-push' prices setting behaviour.

3. There is no price substitution. Neither industries nor consumers will substitute one product for another when relative prices of products change.

4. Each industry will change the prices of all the commodities it produces in the same proportion when confronted with a change in cost.

5. For each commodity the price is a weighted combination of the domestically produced supply and the price of the imported supply of the commodity.

The price models are traditionally used to determine the impact on all industry selling prices and commodity prices of a change in primary factor or import prices. The Statistics Canada price models have been extended so that they may be used to determine the impact of a change in commodity and industry prices as well.

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1. Introduction

The purpose of this note is twofold: to explain
how the Statistics Canada price model can be used to
simulate the cost-push effects of increasing the
domestic price of crude petroleum towards the
international price taking into consideration the
subsidy paid to refiners of imported crude petroleum,
and to present some sample simulations which will serve
to illustrate the results that can be obtained from the
model.

In recent years, the Canadian domestic price of
crude petroleum has been less than the international
price. Canadian refiners of imported crude petroleum
have been subsidized in such a way that the effective
price per barrel of imported crude is equal to the
Canadian domestic price. For example, at the present
time the domestic price of crude petroleum is $16.60 per
barrel delivered in eastern Canada and the international
price is $32.00. Accordingly Canadian refiners of
imported crude petroleum receive a subsidy of $15.40 per
barrel.

In the Canadian input-output tables, imports of
crude petroleum are valued at the international price.
The subsidies paid to Canadian refiners of imported
crude are shown as negative primary inputs into the
refinery industry.

2. Methodological Implications for Price Model
   Simulations

This treatment of crude petroleum in the
Canadian Input-Output tables has implications for users

of the Statistics Canada price model who wish to simulate the cost-push effect of increasing the domestic price of crude petroleum relative to the international price.

Because an increase in the price of domestic crude oil relative to the import price would entail a concomitant decrease in the import subsidy, any simulation of the cost-push effects of raising domestic prices must alter both the domestic relative price and that of the subsidy. The latter may be calculated using the following information:

C = the total value of Canadian oil production for domestic consumption (i.e. total value of production less the value of exports).

Q_c = the quantity (in barrels) of Canadian oil production for domestic consumption.

P_c = the domestic oil price.

M = the total value of imported oil for domestic consumption

Q_m = the quantity of imported oil for domestic consumption

P_m = the price of imported oil

This data is related by the following identities:

(1) $C = Q_c \cdot P_c$

(2) $M = Q_m \cdot P_m$

The subsidy S on imported oil required to maintain an _average_ price P_c for domestic consumption crude oil is therefore given by:

$$\frac{M - S + C}{Q_c + Q_m} = P_c$$

Using relationships (1) and (2) we see that:

$$S = Q_m (P_m - P_c)$$

Therefore, if P_c^1 and S^1 are the "current" domestic price of crude petroleum and import subsidy respectively, and the domestic price to be simulated is P_c^2, the relative prices to be used in the cost-push price model run are,

$$\frac{P_c^2}{P_c^1} \quad \text{for the domestic price of crude petroleum;}$$

and

$$\frac{Q_m (P_m - P_c^2)}{S^1} \quad \text{for import subsidies to the refiners.}$$

Table 1 displays the refinery industry data as it appears (or would appear) in the input-output accounting framework. The first column of this table is a resumé of petroleum refinery statistics from the 1976 I-O tables. The second column shows the same statistics for the year 1980 but using 1979 data to modify the input structure of petroleum refineries. The value of production is calculated from cost changes of the main input i.e., crude oil. (Crude oil represents more than 90% of the inputs of petroleum refineries).

The other data in volume or in values used in the new input structure are the subsidies, taxes and wages and salaries. We assume that the profit margins are constant.

The subsidy is calculated as the product of the difference between the import and domestic prices and the difference between total imports in volume and the quantity of crude oil which will be exported as refined products. A quantity of 20,179,808 barrels of imported crude oil used by the refineries is exported as refined products. The well-head price on January 1st, 1980 is $14.75. The import price for the same period is $32.00. Hence

the subsidy calculated is 3,130,974,000. Taxes are modified by a
new tax (Syncrude Levy) since the first of July 1978. This tax is
now of $0.85/barrel. It represents as amount of $604,228,000.
The other costs are calculated proportionally to the 1976 inputs
(See Appendix 1, a list of inputs of petroleum refineries).

3. Sample Simulations

In the following simulations we change the input structure of
petroleum refineries by applying the new crude oil input
coefficient and the new subsidy coefficient as calculated in
column 3. (See Table 1)

In these simulations we make the assumption that the
industries keep their profit margins constant.

For each simulation we run two versions of the Price Model.
In the open version wages and salaries are considered as exogenous
variables. In the closed version wages and salaries are indexed
to the consumer price index which is calculated internally. And
for this type of experiment we assume that the cost-push effect of
the CPI to Wages and Salaries is fully passed to all industries.

The first run simulates a $5.00 increase in the price of
domestic crude petroleum from the present well-head price of
$14.75 per barrel and the assumed Petroleum Refineries structure
is as in Column 2.

The import coefficient for crude petroleum used is 0.4987.

The relative change in the domestic price of crude petroleum
used in the cost-push price model is

$$\frac{P_c^2}{P_c^1} = \frac{19.75}{14.75} = 1.3389$$

The new subsidy price is calculated as:

$$\frac{Q_m(P_m-P_c{}^2)}{S^1} = \frac{203,310(32-19.75)}{3,130,974} = 0.7954$$

The second run simulates an increase in the domestic price of $17.25 which brings the domestic price to parity with the import price i.e. $32.00. The percent increase in the domestic price is 117% and the new subsidy price for petroleum refineries is zero.

In the third run we assume that the domestic and the import prices of crude petroleum rise to $40.00 per barrel. This means that the relative change for domestic and imported crude petroleum are respectively 171% and 25%, and the subsidy price is down to zero.

To calculate the effects on the purchaser's price of motor gasoline we use the actual cost structure for motor gasoline i.e. the producers' price and tax, the other margins being distributed using the 1976 proportions. The proportions for the producers price and the margins are multiplied by their respective changes in simulations which gives a total percentage change for motor gasoline.

The results are summarized in Table 2.

4. Concluding Remarks

These price simulations represent a "worst case" measure of the inflationary impact of pushing up domestic oil prices in at least three senses:

(1) The simulations assume that the quantity of oil consumed per unit of economic activity does not change in response to the price change; in other words, they assume a total negation of one of the stated goals of increasing oil prices, which is the decreased consumption of oil through substitution and conservation measures.

The inflationary effects should in fact decrease in direct proportion to the expected decrease in oil consumption associated with a price hike.

(2)   The simulations assume that the total direct and indirect price increases in input costs are passed along in output prices.

In fact the market situation may dictate absorbing some of this increase in decreased profits, or decreases in real wages in the case of the simulations closed to labour income.

(3)   The simulations suggest single-year inflationary effects whereas in reality the dynamics of the Canadian economy (dictated by current market conditions, inventories, and the timing of labour contracts) will spread these effects over a longer period of time.

With these caveats in mind, the enclosed oil price simulations can perhaps be viewed as giving an upper bound on the hypothetical inflationary impacts owing to cost-push effects.

TABLE 1

SELECTED INPUT-OUTPUT REFINERY DATA

	1976 (x 1,000)	1979 (x 1,000)
Value of output	$6,893,571	$14,565,138
Value of crude petroleum used		
– Imported	$3,300,286	$ 7,151,680
– Domestic	3,054,749	7,188,633
– Total	6,355,035	14,340,313
Quantity of Crude Petroleum Used (Barrels)		
– Imported	263,435	223,490
– Domestic	355,089	487,367
– Total	618,524	710,857
Value of Subsidy	1,004,326	3,130,974
Crude oil input coefficients	.9218	.9845
Subsidy Input Coefficient	.1466	.2149
Value based import share coefficients	.5193	.4987
Volume based import share coefficients	.4259	.3143

TABLE 2
SUMMARY OF RESULTS
PERCENTAGE CHANGE IN INDEX NUMBERS

	No .1		No.2		No.3	
	OPEN	CLOSED	OPEN	CLOSED	OPEN	CLOSED
consumer expenditure price index	.92	1.82	3.44	6.84	5.15	10.20
Export price index	2.06	3.04	7.37	11.07	10.88	16.40
GNE price index at market price	.83	1.54	3.04	5.71	4.83	8.82
consumer price index	.99	1.94	3.70	7.28	5.52	10.86
CPI food	.77	1.84	2.90	6.29	4.33	10.33
CPI housing	.88	1.80	3.32	6.77	4.95	10.10
CPI clothing	.39	1.51	1.48	5.65	2.20	8.43
CPI transportation	2.51	3.29	9.40	12.34	14.03	18.41
CPI health	.45	1.46	1.68	5.48	2.51	8.18
CPI recreation education and reading	.38	1.43	1.44	5.38	2.15	8.03
CPI tobacco and alcohol	.35	1.09	1.31	4.08	1.95	6.09
CPI non-food petroleum	1.04	1.96	3.91	7.37	5.83	10.99
refineries (ISPI)	22.18	22.37	83.18	83.90	124.08	125.17
Motor Gas.(price per gallon)	1.26	1.27	1.64	1.65	1.88	1.91

ISPI: Industry Selling Price Index

no. 1: $5.00 per barrel increase in domestic oil price with corresponding
            decrease in subsidies.
no. 2: $17.25 per barrel increase in domestic oil price to parity with
            international price, subsidies set to 0.
no. 3:   Both domestic and import prices rise to $40.00 per barrel with
            zero subsidies.

APPENDIX 1

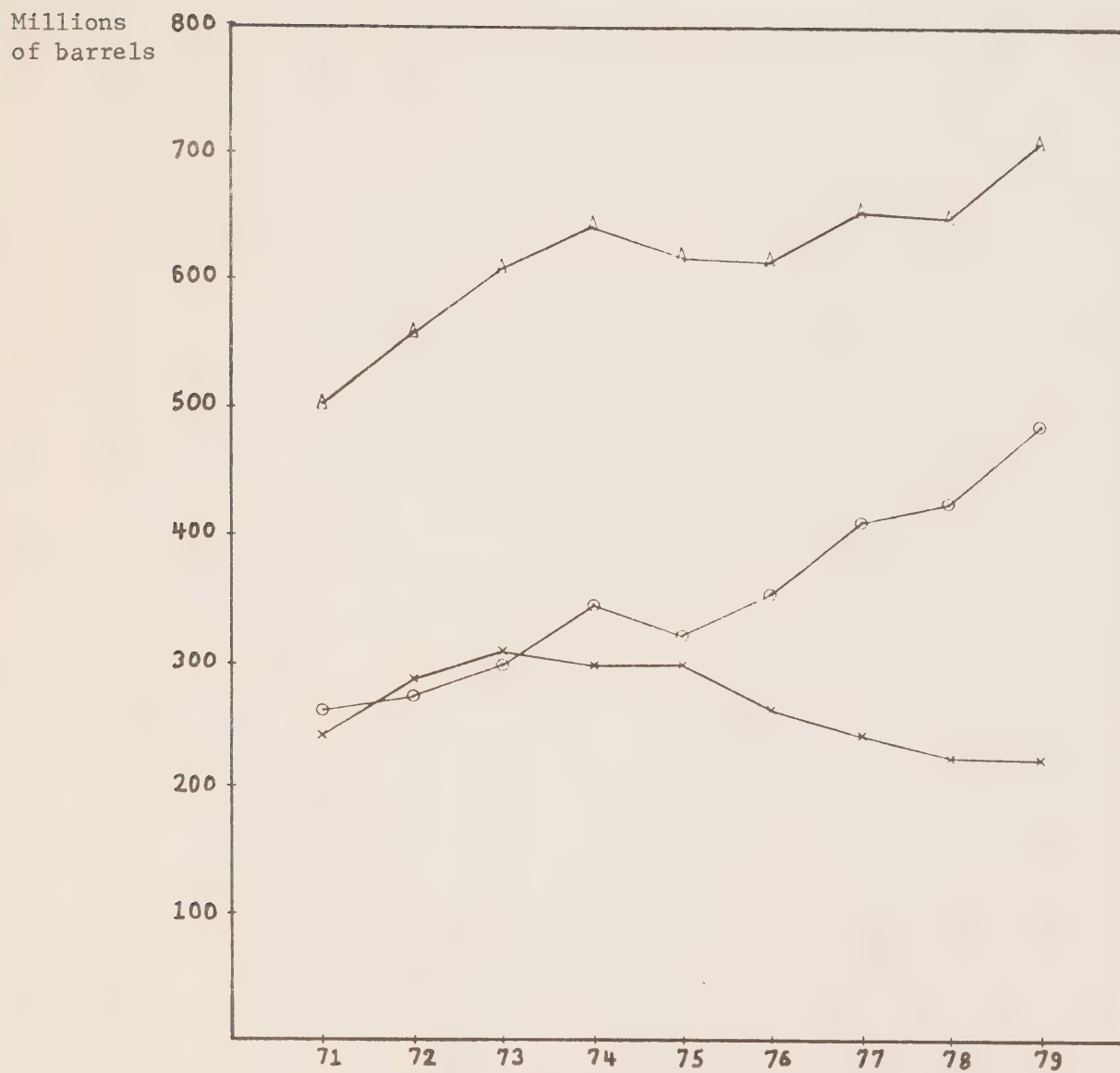## INPUTS TO PETROLEUM REFINERIES – 1976

03800	CRUDE MINERAL OILS
03900	NATURAL GAS
10500	RADIO & TELEVISION RECEIVERS
22100	PAPER CARTONS, BAGS, CANS & BOTTLES
28600	CONTAINERS & BOTTLE CAPS OF METAL
39900	BUTANE, PROPANE & OTHER LIQUID PETROLEUM GAS
41400	INDUSTRIAL CHEMICAL PREP. N.E.S.
41900	CHEMICAL ELEMENTS N.E.S.
42000	SULPHURIC ACID
42200	INORGANIC ACIDS & OXYGEN
42400	CAUSTIC SODA (SOD. HYDROXIDE) DRY
47200	ADDITIVES FOR MINERAL OILS, N.E.S.
48600	COMPOUND CATALYSTS
49300	TANNING MATERIALS AND DYESTUFFS
51500	CUSTOM WORK, MISCELLANEOUS
52200	REPAIR CONSTRUCTION
53400	SERV. INCIDENTAL TO WATER TRANS.
53600	TRUCK TRANSPORTATION
54000	PIPELINE TRANSPORTATION
54400	TELEPHONE AND TELEGRAPH
54500	POSTAL SERVICES
54600	ELECTRIC POWER
54700	GAS DISTRIBUTION
55000	WHOLESALING MARGINS
55400	IMPUTED SERVICE, BANKS
55500	OTHER REAL ESTATE (NON-RENT) & FIN. SERV.
55600	INSURANCE & W.C.B.
55900	OTHER RENT
56600	SERVICES TO BUSINESS MANAGEMENT
57500	RENTAL DATA PROCESSING EQUIPMENT
57600	OTHER SERVICES TO BUSINESSES & PERSONS
57700	RENTAL OF AUTOMOBILES AND TRUCKS
57800	TRADE ASSOCIATION DUES
57900	RENTAL AO MACH. & EQUIPMENT INCL. CONST. MAC
58000	SPARE PARTS & MAINT. SUPPL. MACH & EQUIP.
58100	OFFICE SUPPLIES
58200	CAFETERIA SUPPLIES
58300	TRANSPORTATION MARGINS
58400	LABORATORY EQUIPMENT AND SUPPLIES
58500	TRAVELLING AND ENTERTAINMENT
58600	ADVERTISING & PROMOTION
58700	PURCHASED REPAIR SER. FOR MACH. & EQUIPMENT
59500	GOVERNMENT GOODS AND SERVICES
59600	COMMODITY INDIRECT TAXES
59700	SUBSIDIES
59800	OTHER INDIRECT TAXES
59900	WAGES AND SALARIES
60000	SUPPLEMENTARY LABOUR INCOME

REFERENCES

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   72-002, December 1979 monthly.

Inputs of Crude Petroleum to Canadian Refineries

X   quantity of imported crude petroleum

O   quantity of domestic crude petroleum

△   Total

Sources: Refined petroleum products

APPENDIX 3

Price of Crude Petroleum (Annual Data)

X price of domestic petroleum

O price of imported petroleum